(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 690 315 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
05.12.2001 Bulletin 2001/49

(51) Int Cl.7: **G01S 7/03**, G01S 13/89, H03D 9/06, H01Q 13/08, G01S 13/93

(21) Application number: **95110303.5**

(22) Date of filing: **30.06.1995**

(54) RF sensor and radar for automotive speed and collision avoidance applications

Radargerät mit HF-Sensor für KFz-Geschwindigkeit- und Fahrsicherheitsanwendungen

Dispositif radar et capteur-HF pour applications automobile-vitesse et anticollision

(84) Designated Contracting States:
DE FR GB IT

(30) Priority: **01.07.1994 US 269729**

(43) Date of publication of application:
03.01.1996 Bulletin 1996/01

(73) Proprietor: **RAYTHEON COMPANY**
Lexington, Massachusetts 02173 (US)

(72) Inventor: **Hulderman, Garry N.**
Riverside, California 92509 (US)

(74) Representative: **Kuhnen & Wacker**
Patentanwaltsgesellschaft mbH,
Alois-Steinecker-Strasse 22
85354 Freising (DE)

(56) References cited:
WO-A-89/04496 **US-A- 4 901 084**
US-A- 5 303 419

- **CONF. PROC. 11TH EUROPEAN MICROWAVE CONFERENCE, 7 September 1981, AMSTERDAM, NL pages 443 - 447 MEINEL ET AL 'Low cost Ka-band mixers for Industrial Applications'**
- **IEEE PACIFIC RIM CONF. ON COMMUNICATIONS, COMPUTERS AND SIGNAL PROCESSING, VICTORIA, BC, CA pages 580 - 583, XP000077548 BORNEMANN 'An integrated Ku-Band quasi-planar circuit mixer'**

EP 0 690 315 B1

Description

[0001] The present invention relates to a radar apparatus according to claim 1.

[0002] The assignee of the present invention develops automotive cruise control and collision avoidance systems, and the like. As a result of angular resolution requirements and antenna size limitations, development relating to automotive cruise control and collision avoidance applications has been performed in the 75 to 95 GHz frequency band. Due to the maturity of the technology used at these shorter wavelengths, the majority of the system hardware at these wavelengths uses conventional waveguide transmission and cavity techniques.

[0003] However, waveguide components, manufactured in any form, are limited in how inexpensively they can be produced in high volume production. In addition, given the requirements for less than 2 degree resolution and 30 degree azimuth coverage, heretofore, a narrow beam mechanically scanned antenna has been the only available option. For many reasons a gimbled flapping (mechanically scanned) antenna does not provide an optimum solution.

[0004] Another approach that might be adapted for use in the 75 to 95 GHz frequency band, seldom mentioned due to the present state-of-the-art, is a slotted waveguide phased array antenna. This antenna, with its electronically scanned beam capability, works well at lower frequencies, but has a number of limitations in the 75 to 95 GHz band. These limitations include degraded electrical performance and very high cost even in high production quantities.

[0005] From WO-A-894496 a millimeter wave detecting device is known, comprising:

an array of millimeter wave mixer/detector elements, aligned along an optical path with respect to a field of view;
means for focussing millimeter wave radiation emitted by or reflected from objects in the field of view onto the mixer/detector array;
local oscillator means located out of the optical path for generating a beam of millimeter wave energy; and
a transmitting/reflecting surface means disposed in the optical path for directing the beam of millimeter wave energy onto the array, while permitting focus radiation to traverse the optical path to be incident onto the mixer/detector array;
wherein each of the mixer/detector elements of the array detect and mix the local oscillator beam and focussed radiation from a particular portion of the field of view and provide an output signal responsive to said portion of the field of view.

[0006] It is an object of the present invention to provide a radar apparatus according to the preamble of claim 1, which is capable of achieving a better efficiency in cost and performance of non-mechanical scanning in collision avoidance radar.

SUMMARY OF THE INVENTION

[0007] In order to achieve the above object, the present invention starts out from a radar apparatus according to the preamble of claim 1 and is characterized in that the millimeter wave radar transmitter comprises

a flood beam antenna;
the RF sensor comprises coupler means for coupling the transmitter to each one of a plurality of mixers;
a multiplexer is coupled to the outputs of the plurality of filter circuits and is effective as a multiple input, single output switch for sequentially outputting video signals derived from radar signals received from each of the plurality of antenna elements; and
the RF sensor further comprises

a) a support tube;
b) a pair of support members secured to the tube;
c) a backing plate secured to the support members;
d) a dielectric antenna element board secured to the support members and to the backing plate and comprising the antenna elements; and
e) a slotted waveguide coupled to the backing plate and the dielectric element board for coupling energy between said transmitter and said antenna elements.

[0008] Improved embodiments of the inventive radar apparatus result from the subclaims 2 to 7.

[0009] More particularly, the radar includes a FMCW transmitter, the radar signal processor and the RF sensor. The FMCW transmitter comprises a reference oscillator, a waveform control circuit, a Gunn transmitter that comprises a transmitter and mixer local oscillator for FMCW radar energy transmission, and as a mixer local oscillator for radar energy reception, a beam selector circuit, a harmonic mixer coupled to the Gunn transmitter and to the waveform control circuit, and the flood beam antenna.

[0010] The radar signal processor comprises an amplifier, a video blanking circuit coupled to the amplifier, an analog to digital (A/D) converter coupled to the video blanking circuit, a range/Doppler processor coupled to the analog to digital (A/D) converter, a detect/tracking processor coupled to the range/Doppler processor, a display coupled to the detect/tracking processor, and a master timing reference coupled to the waveform control circuit, the beam selector circuit, the video blanking circuit, the analog to digital (A/D) converter, the range/

Doppler processor, and the detect/tracking processor to control the timing of the signal flow therebetween.

[0011] The RF sensor comprises a receive antenna that includes a plurality of antenna elements, a plurality of mixers respectively coupled to outputs of the plurality of antenna elements and coupled to the Gunn transmitter by means of a coupler, a plurality of filter circuits respectively coupled to outputs of the plurality of mixers, a multiplexer coupled to outputs of the plurality of filter circuits that functions as a multiple input, single output switch for sequentially outputting video signals derived from radar signals received by the receive antenna elements, and a lens for imaging radar returns onto each of the plurality of antenna elements.

[0012] More specifically, each antenna element comprises a linearly tapered slot, a mixer diode coupled to the linearly tapered slot, a planer tuned backshort coupled to the mixer diode, a RF low pass filter coupled to the mixer diode, an amplifier coupled to the RF low pass filter, and an IF low pass filter coupled to the amplifier.

[0013] The RIF sensor comprises a support tube, a pair of support members secured to the tube, a backing plate secured to the support members, a dielectric antenna element board secured to the support members and backing plate that comprises the antenna elements, and a slotted waveguide coupled to the backing plate and dielectric element board for coupling energy out of the antenna elements. Each antenna element may comprise a linearly tapered slot, a mixer diode coupled to the linearly tapered slot, and a planer tuned backshort coupled to the mixer diode.

[0014] The sensor incles two antennas, one for transmission 4,064 cm x 0,4572 cm (1.6 inches x 0.18 inches) and one for reception 12,7 cm (5 inches) in diameter, and operates at 91 GHz. The transmit antenna has a beamwidth of 35 degrees in azimuth illuminating a 55 meter sector in front of a vehicle and a 100 meter ran geand 6 degrees in elevation. The receive antenna comprises a quasioptical focal plane line array, which, with a simple lens shape, provides 16 independent simultaneous overlapping 1.8 degree beams, with a field-of-view of 30 degrees across the azimuth plane. By using optical techniques at the image plane of the lens antenna, it has been possible to incorporate, using printed circuits, the individual integrated (feed-mixer/LO coupler) elements to generate a fully sampled array (1 beamwidth separation). The beam position selection for the sensor is done at the IF frequency output of the individual elements.

[0015] The present invention provides for a very low cost automotive collision avoidance sensor, or RF camera. The present invention provides a very low cost approach to achieving high angle resolution, adequate field-of-view, low loss, and an efficient non-mechanical scanning solution to the automotive collision avoidance problem. As example, the material and labor costs to construct the lens/16 element portion of the first proof-of-principle model was 300 dollars (excluding mixer diodes).

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The various features and advantages of the present invention may be more readily understood with reference to the following detailed description taken in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and in which:

Fig. 1 is a block diagram of an automotive-speed control and collision avoidance system employing an RF sensor or camera in accordance with the principles of the present invention;

Fig. 2 shows a rear view of the receive antenna of the system of Fig. 1;

Figs. 3a, 3b and 3c show top, side and bottom views, respectively, of individual antenna elements of the receive antenna of Fig. 1; and

Fig. 4 shows that for 16 superimposed 1.8° beamwidth element outputs over a 29° FOV, the return energy is changed in angle for the system of Fig. 1.

DETAILED DESCRIPTION

[0017] Referring to the drawing figures, Fig. 1 is a block diagram of an automotive-speed control and collision avoidance system 10 or radar system 10, employing an RF sensor 20, or camera 20, in accordance with the principles of the present invention. Fig. 1 illustrates a system block diagram of a proof-of-principle model of the RF sensor 20. The approach implemented in the present invention extends well-understood optical techniques to longer (1000X) millimeter wavelengths, and employs a low cost fabrication technique to produce printed array elements employed in the sensor 20.

[0018] The system 10 is comprised of an FMCW transmitter 11 that includes a reference oscillator 12, a waveform control circuit 13, a Gunn transmitter 14, a beam selector circuit 16, a harmonic mixer 15, and a flood beam antenna 17. These components are interconnected in a conventional manner as is illustrated in Fig. 1. The Gunn transmitter 14 is used in a conventional manner as a transmitter and mixer local oscillator for FMCW radar energy transmission. The Gunn transmitter 14 is also used in a conventional manner as a mixer local oscillator only, without the use of the flood beam antenna 17, for receiver applications.

[0019] The RF sensor 20 comprises a receiver 21, or receive antenna 21, that includes a plurality of antenna elements 21a. Each of the antenna elements 21a are coupled by way of a mixer 22 through a filter circuit 23 to a multiplexer 24. The multiplexer 24 functions as a multiple input, single output switch 25 that is controlled by means of the beam selector circuit 16 to selectively and sequentially outputting video signals derived from

radar signals received by the receive antenna 21. Each of the mixers 22 is coupled to the Gunn transmitter 14 by means of a coupler 26, as is the harmonic mixer 15. A lens 27 is provided that is used to image radar returns from an image scene onto each of the plurality of antenna elements 21a of the receive antenna 21.

[0020] The output of the multiplexer 24 is coupled to a radar signal processor 30 that includes an amplifier 31 coupled through a video blanking circuit 32 and an analog to digital (AID) converter 33 to a range/Doppler processor 34. The output of the range/Doppler processor 34 is coupled to a detect/tracking processor 35 whose output is coupled to a display 36, for example. A master timing reference 37 is coupled to the wavefotm control circuit 13, the beam selector circuit 16, the video blanking circuit 32, the analog to digital (A/D) converter 33, the range/Doppler processor 34, and the detect/ tracking processor 35 to control the timing of the signal flow between the various components of the system 10.

[0021] A more detailed description of the RF sensor 20 is given below with reference to Figs. 2 and 3a-3c. Details of the receive antenna 21 are shown in Fig. 2, which shows a rear view of the receive antenna 2.1.of the system 10 of Fig. 1. The lens 27 employed in the receive antenna 21 comprises a 13,208 cm (5.2 inch) diameter polystyrene (n = 1.6) plano-convex lens 27 with an f/D = 1.2. The lens 27 is housed in a support tube 40. A pair of support members 41 are secured to the tube 40 which secure a backing plate 42 onto which is disposed a Kapton element board 43 that comprises the antenna elements 21a. A slotted waveguide 44 comprising a plurality of coupling slots 54 (correspond ing to the couplers 26 in Fig. 1) is coupled to the backing plate 42 and Kapton element board 43 that is used to couple energy out of the antenna elements 21a. The coupling slots 54 are formed by etching a copper film that forms a wall of the waveguide 44.

[0022] Individual antenna elements 21a are comprised of a linearly tapered slot 47, a mixer diode 46, a planer tuned backshort 49, a RF low pass filter 51, an amplifier 52, an IF low pass filter 53, and a local oscillator coupling 48, the details of which are shown in Figs. 3a-3c. More particularly, Figs. 3a, 3b and 3c show top, side and bottom views, respectively, of the receive antenna 21 of Fig. 1. The circuit elements shown in Figs. 3a-3c are generally well known in the art.

[0023] A 10 dB illumination taper on the lens 27 is accomplished by using a 0,3048 cm (0.12 inch) slot antenna aperture. This offsets the elements 21a in their physical position from its axial center by 0.75 of the half power beamwidth while allowing them to fully sample the focal plane. At approximately the apex of the tapered slot antenna elements 21a, a GaAs Schottky mixer diode 46 is bonded to two fins 45 of each antenna element 21a. This provides a transition for received RF energy to the impedance of the mixer diode 46. The slot width at the base of the fins 45 is 0.0127 cm (0.005 inches); and serves as a transmission line for the energy not absorbed by the mixer diode 46. The planer tuned back short 49 is positioned at a location that reflects the energy in proper phase back to the mixer diode 46.

[0024] The antenna elements 21a are printed on a sheet of 0.00254 cm (0.001 inch) thick Kapton comprising dielectric element board 43 with 14.175g (0.5 ounce) copper. The size of the sheet dielectric element board 43 is 6.604 cm x 1.905 cm 2.6 inches x 0.75 inches). The element board 43 is registered and bonded using silver epoxy adhesive to the narrow wall of the slotted waveguide 44. The H-plane dimensions of the slotted waveguide 44 are made such that the separation between slots 47 of the slotted waveguide 44 is one wavelength in the waveguide and coincides with the transmission line separation. The angle of the waveguide slots 47 varies to maintain constant output over the length of the slotted waveguide 44. This energy couples through the 0.00254 cm (0.001 inch) thick Kapton dielectric element board 43 into the mixer diodes 46 and serves as the local oscillator. The remaining energy is transmitted into space by way of the flood beam antenna 17.

[0025] There are several options available in selecting the beam position at IF outputs 48 of the antenna elements 21a. The proof of principle model uses a single pole 16 throw switch 25, or multiplexer 24, to connect a desired antenna element 21a to the amplifier 31. Another option may include gain and integration circuitry (provided by the amplifier 52 and IF low pass filter 53) as part of each element so that energy is not lost during IF scanning.

[0026] Tests were conducted on the proof-of-principle system 10 to demonstrate line array operation. The elements 21a were spaced 0.4318 cm (0.17 inches), or one beamwidth, apart. Fig. 4 shows that for 16 superimposed 1.8° beamwidth antenna element outputs over a 29 FOV, the return energy is changed in angle.

[0027] The sensor 20 includes two antennas 17, 21, the transmit antenna 17 (4.064 cm x 0.4572 cm) (1.6inches x 0.18 inches) and the receive antenna 21 (12.7 cm) (5 inches) in diameter, and operates at 91 GHz. The transmit antenna 17 has a beamwidth of 35 degrees in azimuth (illuminating a 55 meter sector in front of a vehicle, for example, on which it is disposed) at a 100 meter range and 6 degrees in elevation. The receive antenna 21 uses the quasioptical focal plane line array of antenna elements 21a, which, in conjunction with a simple shape lens 27, provides 16 independent simultaneous overlapping 1.8 degree beams, with a field-of-view of 30 degrees across the azimuth plane. By using optical techniques, at the image plane of the receive antenna 21, the present sensor 20 incorporates on printed circuits (the element board 43), the individual integrated (feed-mixer/LO coupler) elements 21a that generate a fully sampled array (1 beamwidth separation). The beam position selection for the sensor 20 is done at the IF frequency output 48 of the individual elements 21a.

[0028] The present invention provides a very low cost approach for providing a sensor with high angle resolution, adequate field-of-view, low loss, and an efficient non-mechanical scanning solution for the automotive speed and collision avoidance applications. By way of example, the material and labor costs to construct the lens 27 and 16 antenna elements 21a of the proof-of-principle model of the sensor 20 was 300 dollar, excluding mixer diodes 46.

[0029] As discussed above, the RF sensor 20 was developed for automatic collision avoidance applications where high angular resolution, a large FOV in the azimuth plane, and a single beam in elevation are required. For application requiring a two axis antenna array the element boards 43 may be stacked to produce a 16 x 16 array. Furthennore, while the above-described embodiment employs a 16 element array, the sensor 20 of the present invention may be readily expanded to employ an antenna 21 having 20 elements 21a, for example. Consequently, the present invention is not limited in the number of antenna elements 21a comprising the single plane array. The larger array provides for a larger field-of-view.

[0030] The heart of the present invention is a heterodyne receiver array (the receive antenna 21) that may be used in many applications, including radiometric or radar applications, and the like. The present invention provides for a 35-300 GHz millimeter wave electronic scanning array or sensor 20 for use in collision avoidance applications, and the like. The present invention provides the capability of a conventional mechanically scanned system.

[0031] Thus there has been described a new and improved collision avoidance sensor for use in such automotive speed and collision avoidance systems. It is to be under stood that the above-described embodiment is merely illustrative of some of the many specific embodiments that represent applications of the principles of the present invention.

Claims

1. Radar apparatus (10) comprising

- a millimeter wave radar transmitter (11);
- a radar signal processor (30) for processing radar return signals to produce radar output signals;
- a RF sensor (20) including a receive antenna (21) that comprises a plurality of antenna elements (21a), a plurality of mixers (22) respectively coupled to outputs of said plurality of antenna elements (21a) and a plurality of filter circuits (23) respectively coupled to the outputs of the plurality of mixers (22); and
- a lens (27) for imaging radar returns onto the plurality of antenna elements (21a),

characterized in that

- said millimeter wave radar transmitter (11) comprises a flood beam antenna (17);
- the RF sensor (20) comprises coupler means (26) for coupling the transmitter (11) to each one of said plurality of mixers (22);
- a multiplexer (24) is coupled to the outputs of the plurality of filter circuits (23) and is effective as a multiple input, single output switch (25) for sequentially outputting video signals derived from radar signals received from each of the plurality of antenna elements (21a); and
- said RF sensor (20) further comprises

  a) a support tube (40);

  b) a pair of support members (41) secured to the tube (40);

  c) a backing plate (42) secured to the support members (41);

  d) a dielectric antenna element board (43) secured to the support members (41) and to the backing plate (42) and comprising the antenna elements (21a); and

  e) a slotted waveguide (44) coupled to the backing plate (42) and the dielectric element board (43) for coupling energy between said transmitter (11) and said antenna elements (21a).

2. Apparatus in accordance with claim 1, **characterized in that** each antenna element (21a) comprises:

- a linearly tapered slot (47);
- a mixer diode (46) coupled to the linearly tapered slot (47);
- a planer tuned backshort (49) coupled to the mixer diode (46);
- a RF low pass filter (51) coupled to the mixer diode (46);
- an amplifier (52) coupled to the FR low pass filter (51); and

- an IF low pass filter (51) coupled to the amplifier (52).

3. Apparatus (10) in accordance with claims 1 or 2, ***characterized in that*** the lens (27) is comprised of polystyrene.

4. Apparatus in accordance with claims 1 or 2, ***characterized in that*** the lens (27) has a 10 dB illumination taper.

5. Apparatus according to claim 2, ***characterized in that*** a waveguide slot (54) is provided adjacent the mixer diode (46).

6. Apparatus according to claim 5, ***characterized in that*** the slot taper offsets the physical position of the antenna element (21a) from an axial center by 0.75 of the half power beamwidth while allowing it to fully sample its focal plane.

7. Apparatus according to claim 6, ***characterized in that*** the element board (43) is registered and bonded using adhesive to a wall of the slotted waveguide (44) coupled to the mixer diode (46).

Patentansprüche

1. Radargerät (10) mit:

einem Millimeterwellen-Radarsender (11);

einem Radarsignalprozessor (30) zum Verarbeiten von Radarrückkehrsignalen, um Radarausgangssignale zu erzeugen;

einen HF-Sensor (20) mit einer Empfangsantenne (21), die eine Vielzahl von Antennenelementen (21a), eine Vielzahl von Mischstufen (22), die jeweils an Ausgänge der Vielzahl der Antennenelemente (21a) gekoppelt sind, und eine Vielzahl an Filterschaltungen (23), die jeweils an die Ausgänge der Vielzahl der Mischstufen (22) gekoppelt sind, umfaßt; und
einer Linse (27) zum Abbilden der Radarrückkehrsignale auf der Vielzahl der Antennenelemente (21a),

dadurch gekennzeichnet, daß

der Millimeterwellen-Radarsender (11) eine Flutstrahlantenne (17) aufweist;

der HF-Sensor (20) eine Kopplereinrichtung (26) enthält, um den Sender (11) mit jeder der Vielzahl von Mischstufen (22) zu koppeln;

ein Multiplexer (24) an die Ausgänge der Vielzahl der Filterschaltungen (23) gekoppelt ist und als ein Vielfacheingangs-Einzelausgangsschalter (25) für sequentiell ausgegebene Videosignale wirksam ist, die von den Radarsignalen abgeleitet wurden, welche von jeder der Vielzahl der Antennenelemente (21a) empfangen wurden; und
wobei der HF-Sensor (20) ferner folgendes aufweist:

a) ein Halterungsrohr(40);
b) ein Paar von Halterungsteilen (41), die an dem Rohr (40) befestigt sind;
c) eine Abstützplatte (42), die an den Halterungsteilen (41) befestigt ist;
d) eine dielektrische Antennenelementplatine (43), die an den Halterungsteilen (41) und der Abstützplatte (42) befestigt ist und Antennenelemente (21a) aufweist; und
e) einen geschlitzten Wellenleiter (44), der an die Abstützplatte (42) und die dielektrische Elementplatine (43) gekoppelt ist, um die Energie zwischen dem Sender (11) und den Antennenelementen (21a) zu koppeln.

2. Gerät nach Anspruch 1, **dadurch gekennzeichnet, daß** jedes Antennenelement (21a) folgendes aufweist:

- einen sich linear verjüngenden (tapered) Schlitz (47);
- eine Mischdiode (46), die an den sich linear verjüngenden Schlitz (47) gekoppelt ist;
- einen flach abgestimmten Backshort (planer tuned backshort) (49), der an die Mischdiode (46) gekoppelt ist;
- ein HF-Tiefpaßfilter (51), welches an die Mischdiode (46) gekoppelt ist;
- einen Verstärker (52), der an das HF-Tiefpaßfilter (51) gekoppelt ist; und
- ein IF-Tiefpaßfilter (51), welches an den Verstärker (52) gekoppelt ist.

3. Gerät (10) nach Anspruch 1 oder 2,
dadurch gekennzeichnet, daß die Linse (27) aus Polystyren besteht.

4. Gerät (10) nach Anspruch 1 oder 2,
dadurch gekennzeichnet, daß die Linse (27) eine 10-dB-Beleuchtungsverjüngung (taper) aufweist.

5. Gerät (10) nach Anspruch 2,
dadurch gekennzeichnet, daß ein Wellenleiterschlitz (54) benachbart der Mischdiode (46) vorgesehen ist.

6. Gerät (10) nach Anspruch 5,

dadurch gekennzeichnet, daß die Schlitzverjüngung die physikalische Position des Antennenelements (21a) von einem axialen Zentrum um 0,75 der halben Energiebandbreite versetzt, während ein vollständiges Sampeln der Fokusebene ermöglicht ist.

7. Gerät (10) nach Anspruch 6,
dadurch gekennzeichnet, daß die Elementplatine (43) unter Verwendung eines Klebemittels an einer Wand des geschlitzten Wellenleiters (44), der an die Mischdiode (46) gekoppelt ist, ausgerichtet und gebondet ist.

Revendications

1. Dispositif radar (10), comprenant :

- un émetteur radar en ondes millimétriques (11) ;
- un dispositif de traitement de signaux radar (30) servant à traiter des signaux d'écho radar afin de produire des signaux de sortie radar ;
- un capteur HF (20) comprenant une antenne de réception (21), qui comporte une pluralité d'éléments formant antenne (21a), une pluralité de mélangeurs (22), respectivement reliés à des sorties de ladite pluralité d'éléments formant antenne (21a), et une pluralité de circuits de filtrage (23), respectivement reliés aux sorties de la pluralité de mélangeurs (22) ; et
- une lentille (27) pour former une image des échos radar sur la pluralité d'éléments formant antenne (21a),

caractérisé en ce que

- ledit émetteur radar en ondes millimétriques (11) comprend une antenne à faisceau de lecture (17) ;
- le capteur HF (20) comprend des moyens coupleurs (26) pour relier l'émetteur (11) à chaque mélangeur de ladite pluralité de mélangeurs (22) ;
- un multiplexeur (24) est relié aux sorties de la pluralité de circuits de filtrage (23) et fonctionne en tant que commutateur à entrées multiples et à une seule sortie (25) pour fournir, de manière séquentielle, des signaux vidéo, obtenus à partir de signaux radar reçus de chaque élément de ladite pluralité d'éléments formant antenne (21a) ; et
- **en ce que** ledit capteur HF (20) comprend en outre

a) un tube de support (40) ;
b) une paire d'éléments de support (41) fixés sur le tube (40) ;
c) une plaque de soutien (42), fixée aux éléments de support (41) ;
d) une plaquette d'éléments formant antenne diélectrique (43), fixée sur les éléments de support (41) et sur la plaque de soutien (42) et comprenant les éléments formant antenne (21a) ; et
e) un guide d'ondes à fente (44), couplé à la plaque de soutien (42) et à la plaquette diélectrique d'éléments (43) afin de coupler l'énergie entre ledit émetteur (11) et lesdits éléments formant antenne (21a).

2. Dispositif selon la revendication 1, **caractérisé en ce que** chaque élément formant antenne (21a) comprend :

- une fente à transition progressive linéaire (47) ;
- une diode mélangeuse (46), couplée à la fente à transition progressive linéaire (47) ;
- un élément accordé d'arrêt et de renvoi (49) couplé à la diode mélangeuse (46) ;
- un filtre passe-bas HF (51) relié à la diode mélangeuse (46) ;
- un amplificateur (52) relié au filtre passe-bas HF (51) ; et
- un filtre passe-bas FI (51) relié à l'amplificateur (52).

3. Dispositif (10) selon la revendication 1 ou 2, **caractérisé en ce que** la lentille (27) se compose de polystyrène.

4. Dispositif selon la revendication 1 ou 2, **caractérisé en ce que** la lentille (27) a une décroissance d'illumination de 10 dB.

5. Dispositif selon la revendication 2, **caractérisé en ce qu'**une fente de guide d'onde (54) est située de manière adjacente à la diode mélangeuse (46).

6. Dispositif selon la revendication 5, **caractérisé en ce que** la transition progressive de la fente décale la position physique de l'élément formant antenne (21a) par rapport à un centre axial de 0,75 fois la largeur du faisceau à demi-puissance tout en lui permettant d'échantillonner pleinement son plan focal.

7. Dispositif selon la revendication 6, **caractérisé en ce que** la plaquette d'éléments (43) est alignée et fixée par un adhésif sur une paroi du guide d'ondes à fente (44), couplé à la diode mélangeuse (46).

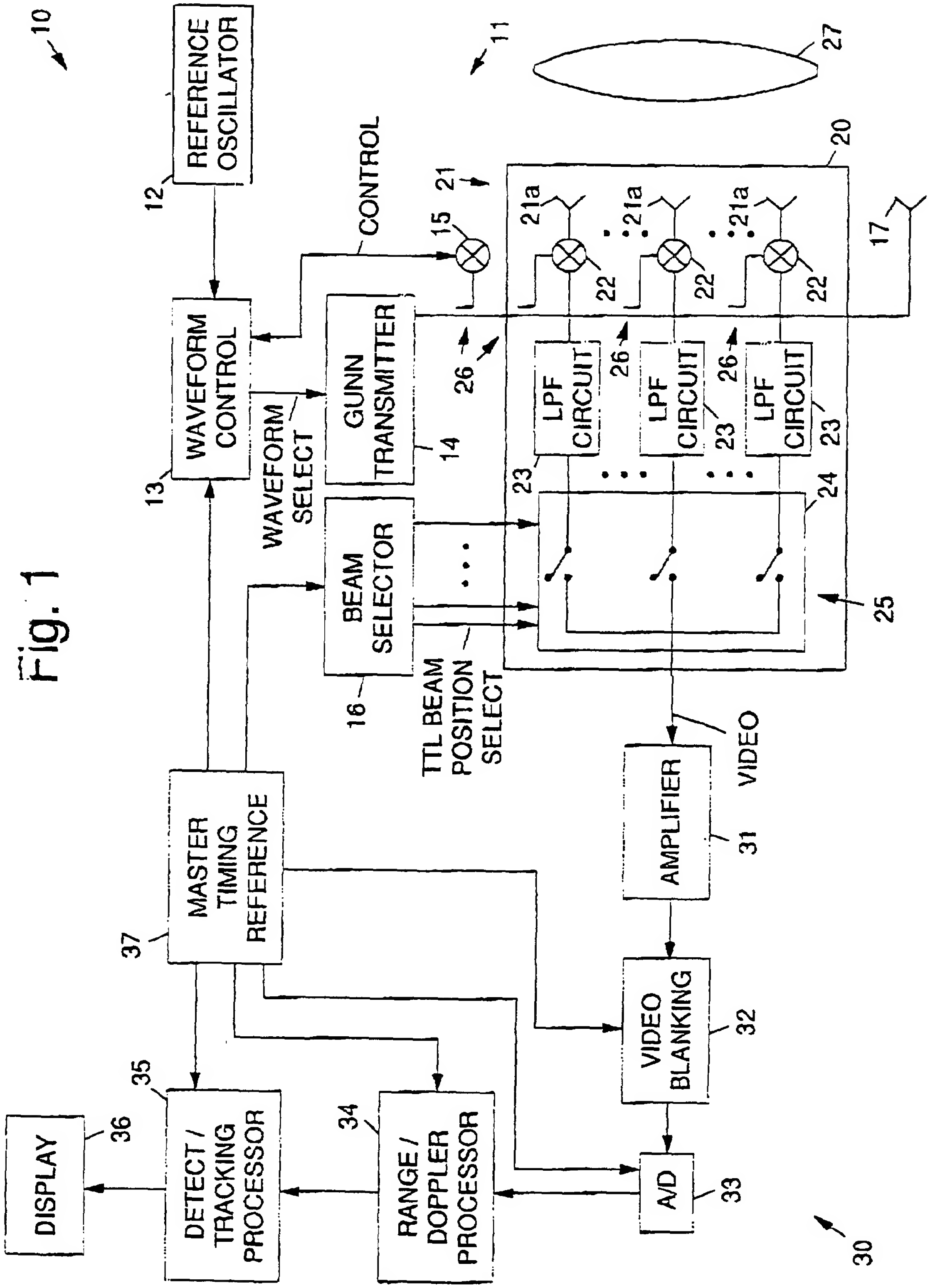

10
REFERENCE OSCILLATOR
12
11
27
CONTROL
WAVEFORM CONTROL
13
GUNN TRANSMITTER
14
WAVEFORM SELECT
BEAM SELECTOR
16
TTL BEAM POSITION SELECT
15
21
21a
22
20
17
26
LPF CIRCUIT
23
24
25
VIDEO
MASTER TIMING REFERENCE
37
AMPLIFIER
31
VIDEO BLANKING
32
A/D
33
30
RANGE / DOPPLER PROCESSOR
34
DETECT / TRACKING PROCESSOR
35
DISPLAY
36

Fig. 1

Fig. 2

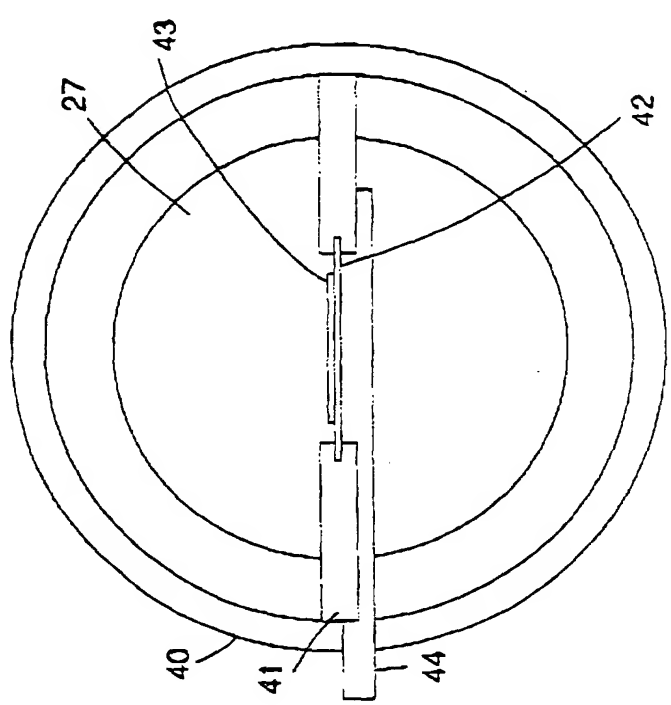
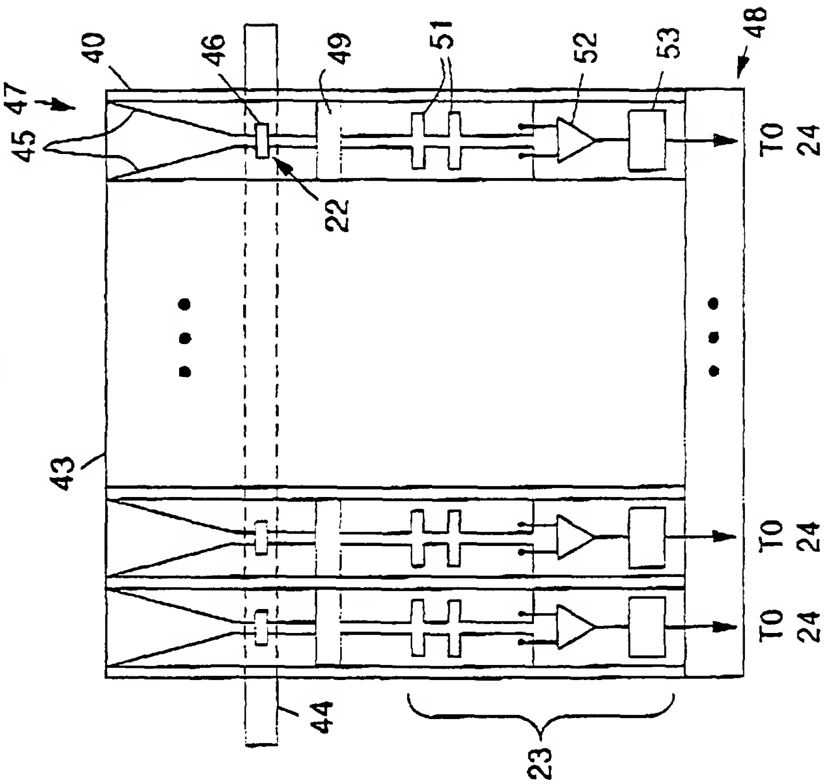

27
43
42
40
41
44

Fig. 3a


45
47
40
46
49
51
52
53
48
22
43
44
23
TO 24
TO 24
TO 24

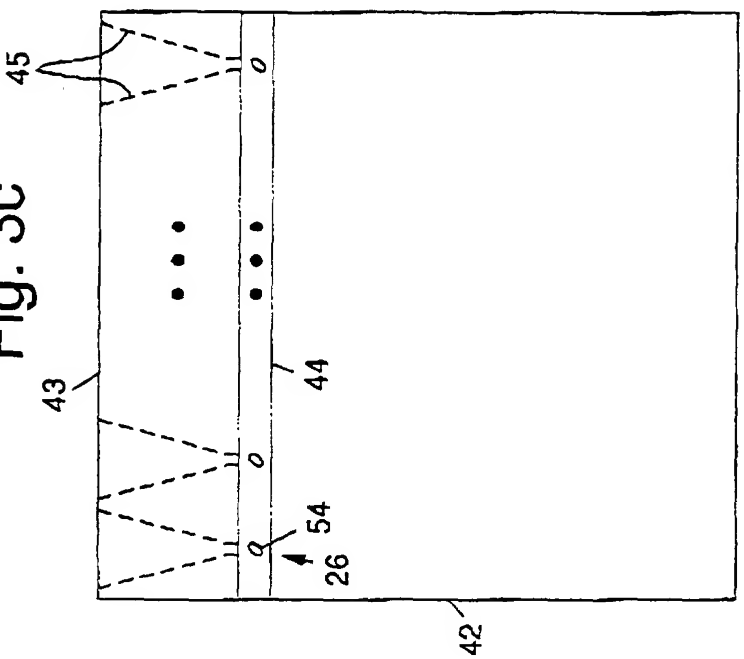


Fig. 3c

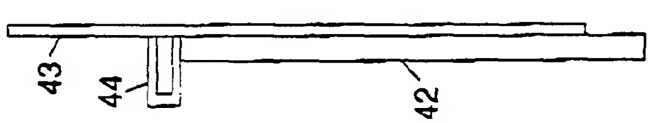


Fig. 3b

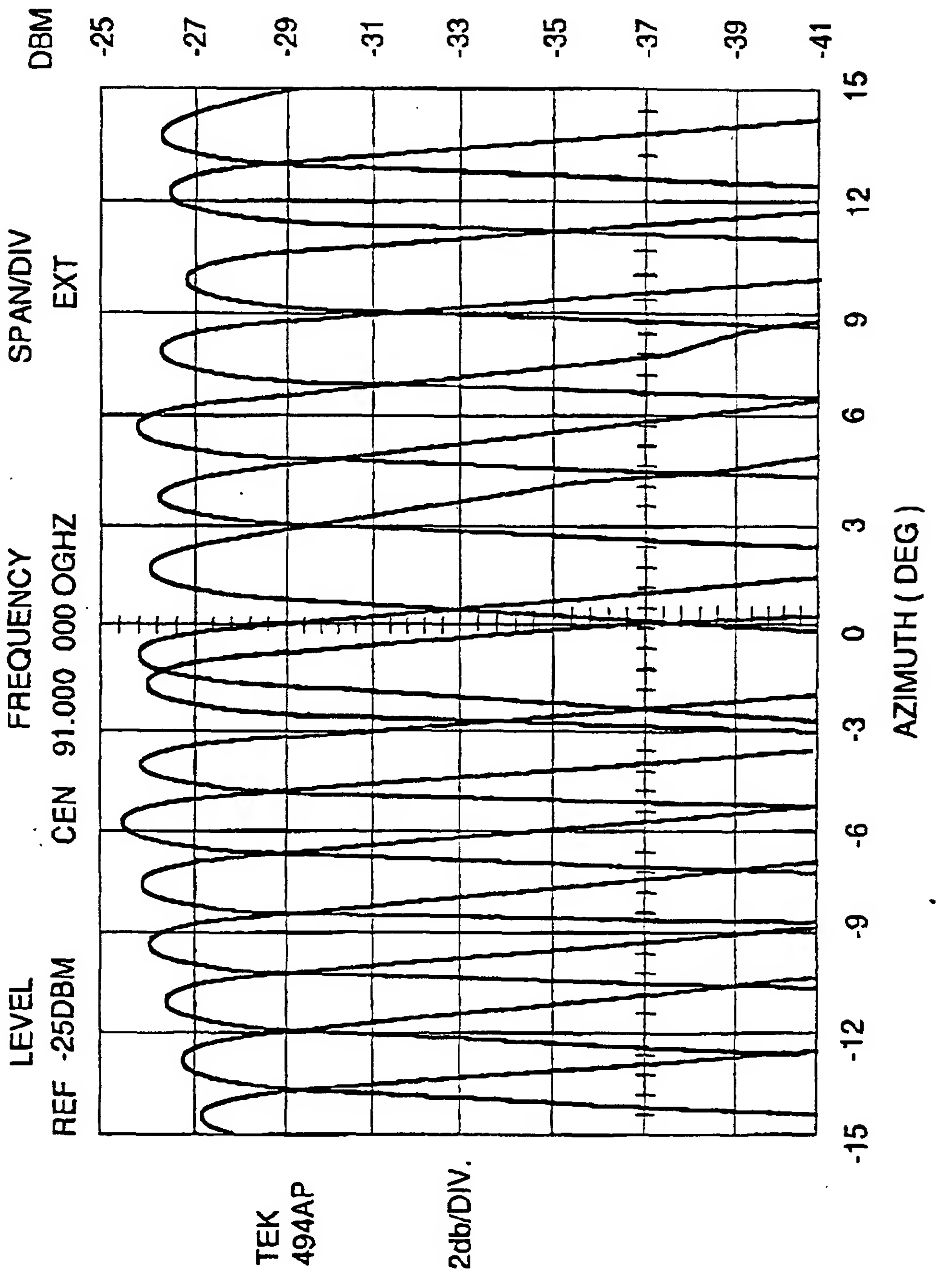

REF LEVEL -25DBM
CEN FREQUENCY 91.000 000 OGHZ
SPAN/DIV EXT
DBM
-25
-27
-29
-31
-33
-35
-37
-39
-41
-15
-12
-9
-6
-3
0
3
6
9
12
15
AZIMUTH (DEG)
TEK 494AP
2db/DIV.

FIG.4.